



Phytodiversity of Barail Wildlife Sanctuary, Assam, India: field-based observations—I. Trees and lianas

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Abstract

Trees and lianas were inventorized in Barail Wildlife Sanctuary, Assam, India, which revealed the occurrence of 112 and 23 species of trees and lianas respectively. Two separate lists, one for trees and other for lianas, of all the enumerated taxa are presented here with their vernacular names, phenology, places of occurrence and collection number(s). Threat status of each taxon according to IUCN Red List categories is also provided. Anthropogenic activities and other natural calamities are causing serious threats particularly to the tree diversity of the sanctuary. In addition, destruction of one tree may eradicate many lianas from a particular area. Thus, many species of trees and lianas are under alarming threat in the sanctuary. Conservation through *in situ* and *ex situ* modi operandi is recommended.

Key words

Arboreal angiosperms; Barak Valley; biodiversity; Cachar; species inventory; woody climbers.

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Introduction

Inventorization of plants of a particular area comprises basic biodiversity studies and assessment of their conservation status. Among various ecoclimatic zones, tropical evergreen forests constitute one of the most biodiversity rich habitats on the globe (Khandekar and Srivastava 2014). An exhaustive inventory of tropical plant species is, thus, one of the primary objectives for the plant taxonomists. Within India, the tropical monsoon climate that prevails in the Eastern Himalayas, Northeastern India, and Western Ghats allows for a rich and diverse flora. Though steps have been taken towards cataloguing the biodiversity of protected areas in India, knowledge of the diverse flora of many protected areas, particularly in northeastern India, is still lacking. There was no comprehensive study on the diversity of angiosperms of Barail

Wildlife Sanctuary (BWS), Assam, India, and hence, we initiated this study to investigate the same of BWS for the first time. Because the angiosperm flora of BWS is large, we have segregated the study into 2 parts. A second part, which will include herbs, shrubs, and non-woody climbers, is planned for a later publication.

Tropical vegetation, mostly dominated by angiosperm trees, is a large part of floral diversity. Trees are important in that they provide shade and shelter for herbaceous and epiphytic plants. They provide homes for wild animals, especially primates. They stabilise the soil, counteract rapid run-off of rainwater, and prevent desertification, and they have a role in climate control and in the maintenance of biodiversity and ecosystem balance (Bellefontaine et al. 2002). Trees are also economically important for yielding timber, fuel, and food.

Lianas, or woody climbers, are likewise important components of tropical forests and are important for the forest community and structure. They are generally long-stemmed, reaching up into the tree canopy to get access to light. Their structural morphology and mechanisms of twining add to the complexity of the vertical structures of forests (Chaudhuri and Naithani 1985). According to Grubb (1977), dense vegetation of lianas in a particular area portray the nature of tropical lowland and lower montane forest types of that region. Like trees, lianas also contribute substantially to the diversity of the forests and provide food and arboreal pathways for forest animals. They are widely used for medicine, food, house construction, and artisan work. They have an important role in forest regeneration (Bongers et al. 2002).

The first comprehensive floral account of Assam was the *Flora of Assam* (Kanjilal et al. 1934–1940). Subsequently, Das (1942) documented preliminary data on flora of Assam. Recently, Choudhury (2005) and Barooah and Ahmed (2014) provided checklists of the vascular plants, particularly angiosperms and gymnosperms, of the state. Additionally, smaller works on the flora in various areas of the state, particularly from the Brahmaputra Valley region, include: Rao and Rabha (1966), Rao and Verma (1970, 1972, 1973, 1976), Islam (1986, 1990, 1990a, 1991), Sarma (1990), Barua (1992), Choudhury et al. (1994), Agarwal and Borah (2001), Barooah and Mahanta (2006), Sarma et al. (2006).

By comparison, the Barak Valley (southern Assam), where Barail Wildlife Sanctuary is situated, has received very little attention by botanists. Dutt et al. (1974) prepared a preliminary checklist of the Polypetalae of North Cachar Hills and Barail range (particularly the Haflong hills). Other reports from Barak Valley were made by Sharma et al. (2002), Das and Dutta Choudhury (2003), Nath and Maiti (2003), Baruah et al. (2006), Das et al. (2006, 2007, 2008), Barbhuiya et al. (2009), Darlong and Bhattacharyya (2011), Rout et al. (2012), Darlong et al. (2013), Barbhuiya 2013a, Devi and Bhattacharyya (2013, 2013a, 2013b, 2014, 2016), Barbhuiya 2014, Barbhuiya et al. (2014), and Devi et al. (2014). Das et al. (2013) and Baruah and Dutta Choudhury (2015) listed the herbaceous plants of Barak Valley, focusing on their economic utility.

Among the angiosperms of the BWS, while describing a new Asian genus of ginger, *Larsenianthus*, Kress et al. (2010) reported 2 species of the genus from the sanctuary viz. *L. assamensis* S. Dey, Mood & S. Choudhury (described as new to science from BWS) and *L. careyanus* (Benth.) W.J. Kress & Mood. Barbhuiya et al. (2012) and Barbhuiya (2013) described 2 new species, *Ornithochilus cacharensis* Barbhuiya, B.K. Dutta & Schuit. (Orchidaceae) and *Toxicodendron bimannii* Barbhuiya (Anacardiaceae), respectively. Barbhuiya et al. (2012a) rediscovered *Ardisia keenanii* C.B. Clarke (Myrsinaceae) after a gap of 138 years from the sanctuary. First collection of this species from the study area was made by R.L. Keenan in 1873. Later, C.B. Clarke (1882) described it in *Flora of British India* based on his own collection from

Manipur in 1868 and Keenan's collection from Cachar in 1873. Barbhuiya et al. (2013) documented 96 species of grasses from Barak Valley, including 16 species from the BWS.

As can be seen from the literature, it is evident that baseline data on angiosperm diversity of the BWS is mostly scattered and inadequate. Hence, we initiated this study to provide a comprehensive list of angiosperms in the sanctuary. In this first part, we treat the trees and lianas of the protected area.

Methods

Study site. Barail Wildlife Sanctuary (BWS) is situated in the northern part of Cachar district of Assam and lies along the foothills of the North Cachar and Barail hills. It covers an area of just over 326 km². The BWS is under the administrative control of the Southern Assam Forest Circle, Silchar, and consists of Barail Reserve Forest, which is part of the Cachar Forest Division (East Block) and North Cachar Reserve Forest, part of the Karimgunj Forest Division (West Block) (Fig. 1).

The climate is tropical and humid; the average annual rainfall is 3383.5 mm/year and the average humidity is 72–83%. The minimum and maximum temperatures recorded during our study were 12.6 °C and 32.7 °C, respectively.

Major rivers draining the sanctuary are the Jatinga, Daloo, Kayong, Gumra, and Boleswar. The sanctuary is characterized by undulating hills having altitudinal range of less than 30 m to more than 1800 m in the Barail hills, where the towering peaks are Hamplopet (1,867 m), Kua-kaha (1,736 m), Maheo (1,739 m), and Sherpai (1,657 m) (Anonymous 2006). Geologically, the soils are sandy-stony to clayey (Anonymous 2006). The area is one of the richest treasure houses of flora as well as fauna due to its unique geographical position, diverse landscapes, wide range of physiographic conditions and high precipitation.

As per classification of Champion and Seth (1968), the sanctuary has 2 broad groups of forests, tropical wet evergreen and tropical semi-evergreen forests.

Field survey and data collection. We made extensive and intensive field observations and collections from 2013 to 2016 (Table 1), from various habitats and forest types (Figs 2, 3). Our surveys and collections were done with the permission from the Divisional Forest Officer, Cachar Division, Silchar (letter No.B/35/Misc.7344-45, dated Silchar, 21 November 2013). Although we surveyed in almost all seasons, most field surveys were done during the pre-monsoon and post-monsoon seasons. Specimens were collected mostly during their flowering and fruiting stages. Vernacular names, phenological data, and ecological notes were compiled from our field observations and a survey of the literature; these data were supplemented by collectors' notes on herbarium sheets. The IUCN Red List was used to categorize species (IUCN 2017) into different Red List categories.

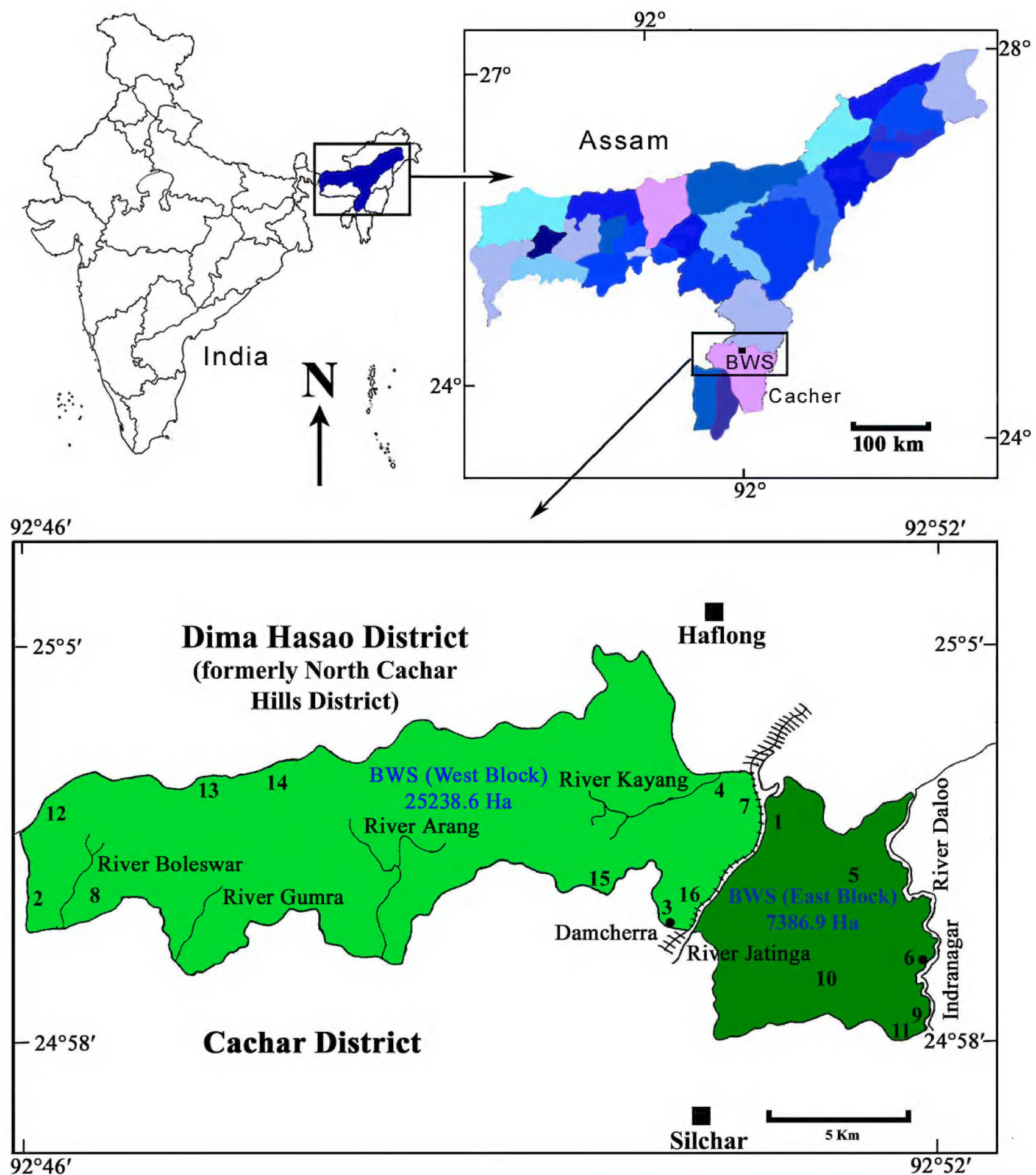


Figure 1. Map of the Barail Wildlife Sanctuary in Assam, India. See Table 1 for numbered localities.

Table 1. Localities, with dates of collections (surveys were 4–5 days at each location), elevation, and geographic coordinates. Locality number corresponds to numbers in Figure 1.

No.	Location	Date	Elevation (m)	Latitude (N)	Longitude (E)
1	Bandarkhal and vicinity	24-IX-2013	94–102	25°16'	092°51'
2	Craig Park Tea Estate, Kalain	26-XI-2014	19–20	25°00'	092°52'
3	Damcherra and vicinity	11-III-2013, 12-XII-2013, 12-XII-2014	23–67	25°01'	092°49'
4	Ditekcherra	12-XII-2013	92–105	25°00'	092°51'
5	Durbintila (on way to peak from foothills)	12-XII-2013, 08-III-2014, 26-II-2016	105–1050	24°95'	092°51'
6	Indranagar	18-V-2013	22–65	24°55'	092°52'
7	Jatingacherra and vicinity	28-II-2015	965–970	25°50'	092°49'
8	Kalain Tea Estate, hill no. 15	26-XI-2014	78–85	24°55'	092°47'
9	Kumba	02-IV-15	69–75	24°94'	092°52'
10	Lakhicherra	24-IV-2014	105–110	24°58'	092°50'
11	Madhura Khuwari	05-IV-2013, 07-IV-2013	25–35	26°11'	091°83'
12	Malidahar	03-III-2013, 12-XII-2015	15–25	25°03'	092°38'
13, 14	Malidahar Mikir punji and vicinity	12-XII-2015	19–30	25°01'–25°08'	092°48'–092°59'
15	Maruacherra	08-III-2014	105	24°99'	092°50'
16	SCF Nala, on way to Damcherra	25-IV-2015	103–135	24°59'	092°45'



Figure 2. Forest habitats at various locations of Barail Wildlife Sanctuary. **A.** SFC Nala. **B.** Durbintila. **C.** Indranagar. **D.** Malidahar. **E.** Confluence of Kayang and Jatinga River. **F.** Lakhicherra.

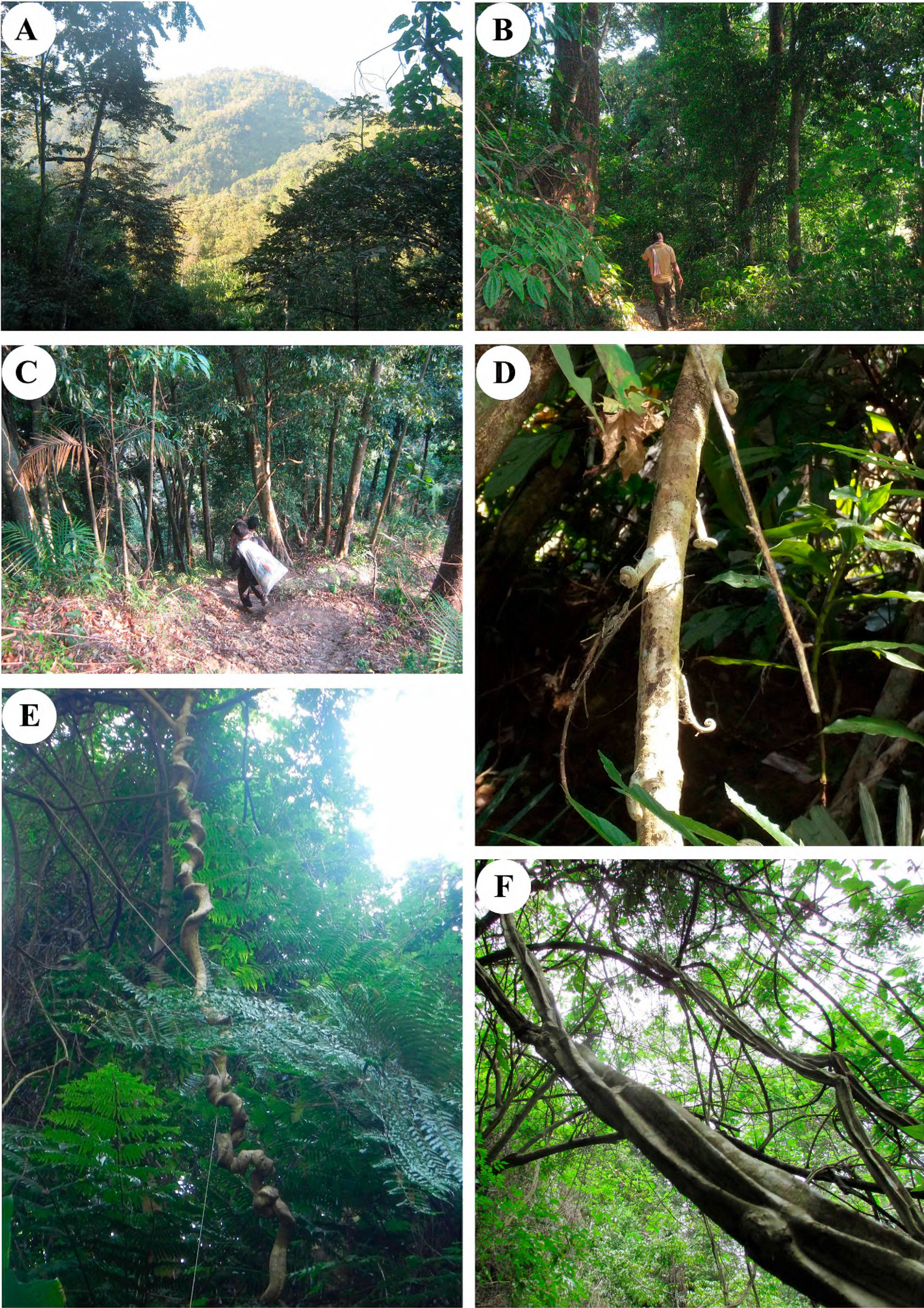


Figure 3. Forest environments of the study area. **A–C.** Dense forests in core areas. **D–F.** Liana dominated forests.

Processing of specimens. The drying, treatment with chemicals, and mounting of our specimens were done following the routine herbarium practices (Jain and Rao 1977, Singh and Subramaniam 2008). Voucher specimens were deposited in the Plant Taxonomy and Biosystematics laboratory, Department of Life Science and Bioinformatics, Assam University, Silchar (here abbreviated as AULS; Tables 2, 3).

Identification of species. We studied the external morphological characteristics, including those of dissected, mainly floral parts, of all collected specimens using an Olympus SZ61 stereomicroscope. Characteristics of each species and infraspecific taxon were noted. Preliminary identifications were made using keys in authoritative literature (Brandis 1906, Kanjilal et al. 1934–1940, Chaudhuri and Naithani 1985). We confirmed the identifications of our specimens with authentic herbarium specimens housed in Indian herbaria (ASSAM, BSD, CAL, DD, GUBH, and LWG; acronyms according to Thiers 2011) and with images of type specimens available in online databases. The *International Plant Name Index* (IPNI 2012), *The Plant List* (2013) and *Tropicos* (2017) were consulted for current nomenclature of all taxa. The Angiosperm Phylogeny Group III Classification (APG III 2009) was followed for the classification of families. Families and species in our list are arranged in alphabetical order.

Results

Floristic diversity. Our study revealed 112 species of trees belonging to 86 genera and 43 families (Table 2), and 23 species of lianas in 17 genera and 13 families (Table 3).

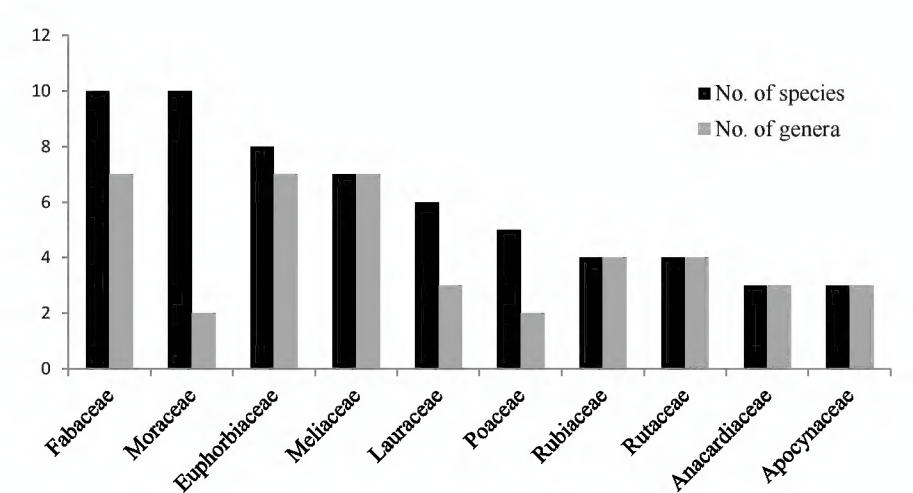


Figure 4. Dominant tree families with number of species and genera.

Of the species of trees, among the dicotyledons, the most dominant families were Fabaceae and Moraceae with 10 species each, followed by Euphorbiaceae (8), Meliaceae (7), Lauraceae (6), and Rubiaceae and Rutaceae (4 each) (Fig. 4). Seven families—Anacardiaceae, Apocynaceae, Bignoniaceae, Combretaceae, Elaeocarpaceae, Malvaceae, and Myrtaceae—each had 3 species. Actinidiaceae, Boraginaceae, Dilleniaceae, Lamiaceae, Primulaceae, Rhamnaceae, and Verbenaceae had 2 spp. each. The remaining 20 families were represented by a single species in the BWS. *Ficus* (6 spp.), followed by *Artocarpus* (4 spp.), *Bauhinia*, *Litsea*, and *Terminalia* (3 spp. each) were the dominant genera in terms of species numbers. Among the monocotyledons, only Poaceae (5 spp.) and Arecaceae (3 spp.) were recorded. Bamboos (Poaceae) and Areca nut (Arecaceae) were 2 dominant floral components in parts of the BWS.

Of the lianas, among the dicotyledons, the most dominant families were Fabaceae (8 spp.), followed by

Table 2. List of trees with their vernacular names, phenology, collection number, occurrence and threat status. Abbreviations, languages: A = Assamese, B = Bengali, Di = Dimasa, E = English, H = Hindi, K = Kuki, Sylh. = Sylheti; IUCN status: DD = Data Deficient, LC = Least Concern, NE = Not Evaluated and V = Vulnerable. Occurrence: see Table 1 for a key to locations.

Scientific name	Vernacular name	Phenology	Voucher specimens	Occurrence	Threat status
Dicotyledons					
Actinidiaceae Engl. & Gilg					
<i>Saurauia cerea</i> Griff. ex Dyer	Not known	July–Nov.	AB & DB 11479; AULS 2554	10	NE
<i>Saurauia roxburghii</i> Wall.	Arbeng-thing (B)	March–Aug.	AB & DB 11606; AULS 2560	11	NE
Anacardiaceae R.Br.					
<i>Lannea coromandelica</i> (Houtt.) Merr.	Kuhimola (A)	Feb.–June	AB & DB 11518; AULS 2551	16	NE
<i>Mangifera indica</i> L.	Aam (A and B)	Year round	AB & DB 11554; AULS 2557	1, way to 7	DD
<i>Spondias pinnata</i> (L.f.) Kurz	Amora (A)	March–Dec.	AB & DB 11555; AULS 2563	way to 1	NE
Annonaceae Juss.					
<i>Annona squamosa</i> L.	Atlash kothal (A), Sugar apple (E)	June–Sept.	AB & DB 11556; AULS 2568	1	NE
Apocynaceae Juss.					
<i>Alstonia scholaris</i> (L.) R.Br.	Sotiona (A), Chhatim (B)	June–Dec.	AB & DB 11515; AULS 2556	1, way to 7	LC
<i>Holarrhena pubescens</i> Wall. ex G.Don	Dhulkari (A), Kurchi (B)	Apr.–Dec.	AB & DB 11734; AULS 2571	4	LC
<i>Plumeria rubra</i> L.	Goalanchi (A)	June–Dec.	AB & DB 11558; AULS 2562	1	NE
Araliaceae Juss.					
<i>Trevesia palmata</i> (Roxb. ex Lindl.) Vis.	Snowflake Tree (E)	Oct.–July	AB & DB 11431; AULS 2580	5	NE
Bignoniaceae Juss.					
<i>Oroxylum indicum</i> (L.) Kurz	Thukuna gach (B)	Jan.–March	AB & DB 11564; AULS 2585	5	NE

Table 2. Continued.

Scientific name	Vernacular name	Phenology	Voucher specimens	Occurrence	Threat status
<i>Pajanelia longifolia</i> Schum	Wild Trumpet tree (E), Hona, Kawarinoa (Sylh.)	Dec.–May	AB & DB 11565; AULS 2588	5	NE
<i>Stereospermum chelonoides</i> DC.	Parhori, Paroli (A), Fragrant Padri tree (E)	Apr.–Jan.	AB & DB 11761; AULS 2597	6	NE
Boraginaceae Juss.					
<i>Cordia myxa</i> L.	Bowal (A), Indian cherry (E)	May–Dec.	AB & DB 11777; AULS 2582	16	NE
<i>Ehretia acuminata</i> R.Br.	Bowal gach, gual, pojhar (A), Koda Tree (E)	March–Jan.	AB & DB 11524; AULS 2594	3	NE
Burseraceae Kunth					
<i>Garuga pinnata</i> Roxb.	Bombuk, Engla (B)	March–Oct.	AB & DB 11569; AULS 2600	5	NE
Caprifoliaceae Juss.					
<i>Viburnum cylindricum</i> Buch.-Ham. ex D.Don	Not known	June–Oct.	AB & DB 11413; AULS 2617	3	NE
Capparaceae Juss.					
<i>Crateva religiosa</i> G.Forst.	Barun Gach (A)	March–Sept.	AB & DB 11771; AULS 2613	11	NE
Caricaceae Dumort.					
<i>Carica papaya</i> L.	Omita (A), Papaya (E)	March–Dec.	AB & DB 11578; AULS 2568	1	NE
Clusiaceae Lindl.					
<i>Mesua ferrea</i> L.	Nahor (A), Nageswar (H), Laternga (Jaintia)	March–Oct.	AB & DB 11755; AULS 2552	6	NE
Combretaceae R.Br.					
<i>Terminalia bellerica</i> (Gaertn.) Roxb.	Bhumora (A), Bohera (B)	March–July	AB & DB 11756; AULS 2573	6	NE
<i>Terminalia chebula</i> Retz.	Silikha (A), Haritoki (B), Sohartaki (Jaintia)	May–Dec.	AB & DB 11580; AULS 2623	1	NE
<i>Terminalia myriocarpa</i> Van Heurck & Müll.Arg.	Hollokh (A), Jhalna (B)	Aug.–Jan.	AB & DB 11757; AULS 2601	6, 11	NE
Datiscaceae Dumort.					
<i>Tetrameles nudiflora</i> R.Br.	Bhelu (A), Chundul (B)	March–May	AB & DB 11779; AULS 2610	16	LC
Dilleniaceae Salisb.					
<i>Dillenia indica</i> L.	Ou tenga (A), Chalta (B)	July–Jan.	AB 11586; AULS 2628	Kalaincherra stream (through 8)	NE
<i>Dillenia pentagyna</i> Roxb.	Akshi, Okshi (A)	Apr.–Sept.	AB & DB 11763; AULS 2619	11	NE
Dipterocarpaceae Blume					
<i>Shorea robusta</i> C.F.Gaertn.	Sal (A)	Jan.–July	AB 11746; AULS 2605	12	LC
Elaeocarpaceae Juss. ex DC.					
<i>Sloanea sterculiacea</i> Rehder & E.H.Wilson var. <i>assamica</i> (Benth.) Coode	Joba-hingori, Bandor-kakoi (A)	Oct.–Apr.	AB & DB 11768; AULS 2644	11	NE
<i>Elaeocarpus floribundus</i> Blume	Jalphai (A), Belphai (B)	May–Dec.	AB 11748; AULS 2651	Kalaincherra stream (through 8)	NE
<i>Elaeocarpus lanceifolius</i> Roxb.	Not known	June–Sept.	AB 11504; AULS 2657	Kalaincherra stream (through 8)	NE
Euphorbiaceae Juss.					
<i>Antidesma ghesaembilla</i> Gaertn.	Heloch, Mikhan-tenga (A), Black Currant Tree (E)	March–Jan.	AB & DB 11303; AULS 2564	3	NE
<i>Aporosa octandra</i> (Buch.-Ham. ex D.Don) A.R.Vickery	Bara-heloch (A), Kokra (B)	Jan.–Dec.	AB & DB 11607; AULS 2553	11	NE
<i>Bischofia javanica</i> Blume	Urim (A)	Apr.–Oct.	AB & DB 11461; AULS 2592	10	NE
<i>Glochidion khasicum</i> Hook.f.	Not known	June–Nov.	AB & DB 11434; AULS 2599	5	NE
<i>Glochidion lanceolarium</i> (Roxb.) Voigt	Not known	Apr.–Feb.	AB & DB 11480, 11497; AULS 2583	10	NE
<i>Macaranga denticulata</i> (Blume) Mull.Arg.	Moralia (A), Jagura (B)	Apr.–Oct.	AB 11311, 11450; AULS 2575	5, 12	NE
<i>Mallotus philippensis</i> (Lam.) Mull.Arg.	Monkey-face Tree (E), Kamala (H)	March–Aug.	AB & DB 11425; AULS 2602	5	NE
<i>Phyllanthus emblica</i> L.	Amlakhi (A)	Apr.–Sept.	AB & DB 11749; AULS 2625	6	NE
Fabaceae Lindl.					
<i>Bauhinia acuminata</i> L.	Kanchan (B)	Apr.–Dec.	AB & DB 11437; AULS 2674	5	NE
<i>Bauhinia purpurea</i> L.	Kanchan (B)	Sept.–March	AB 11388, 11688; AULS 2684	2, 3	LC
<i>Bauhinia variegata</i> L.	Kotora (A), Raktakanchan (B)	Dec.–Sept.	AB & DB 11740; AULS 2689	on way to 1	LC
<i>Cassia fistula</i> L.	Shonalu (B)	Apr.–Jan.	AB & DB 11733; AULS 2640	11	NE

Table 2. Continued.

Scientific name	Vernacular name	Phenology	Voucher specimens	Occurrence	Threat status
<i>Cassia javanica</i> L. subsp. <i>nodosa</i> (Buch.-Ham. ex Roxb.) K.Larsen & S.S.Larsen	Apple blossom cassia (E)	Aug.–Jan.	AB & DB 11547; AULS 2648	5	NE
<i>Dalbergia sericea</i> Spreng.	Not known	Apr.–Sept.	AB 11604, 11684; AULS 2660	11, 12	NE
<i>Erythrina variegata</i> L.	Indian coral tree (E)	Feb.–Aug.	AB & DB11732; AULS 2678	6, 11	LC
<i>Pongamia pinnata</i> (L.) Pierre	Karchaw (A)	May–Oct.	AB & DB 11522; AULS 2661	16	LC
<i>Saraca asoca</i> (Roxb.) de Wilde	Ashok (B)	March–July	AB & DB 11474; AULS 2672	10	V
<i>Tamarindus indica</i> L.	Teteli (A), Tetul (B)	May–Apr.	AB 11576; AULS 2607	2	NE
Lamiaceae Martinov					
<i>Callicarpa arborea</i> Roxb.	Bonmola/Gunmola/Khoja (A), Bormala (B), Beautyberry Tree (E)	May–Dec.	AB & DB 11531; AULS 2630	16	NE
<i>Premna bengalensis</i> Clarke	Gohora (A)	May–Nov.	AB & DB 11760; AULS 2615	6, 11	NE
Lauraceae Juss					
<i>Alseodaphne owdeni</i> R.Parker	Tilsundi (Cach.)	May	AB & DB 11775; AULS 2558	16	NE
<i>Cinnamomum glanduliferum</i> (Wall.) Meisn.	Gonhorai (A)	March–Sept.	AB & DB 11762; AULS 2567	11	NE
<i>Cinnamomum tamala</i> (Buch.-Ham.) T.Nees & C.H.Eberm.	Tej-pat (A)	Apr.–Oct.	AB & DB 11730; AULS 2608	11	NE
<i>Litsea cubeba</i> Pers.	May Chang / Mountain Pepper (E)	Feb.–Aug.	AB 11502; AULS 2621	Kalaincherra (through 8)	NE
<i>Litsea glutinosa</i> (Lour.) C.B.Rob.	Indian laurel (E)	May–Oct.	AB & DB 11625; AULS 2654	11	NE
<i>Litsea monopetala</i> (Roxb.) Pers.	Sowalu (A)	May–Nov.	AB & DB 11447; AULS 2637	5	NE
Lecythidaceae Poiteau					
<i>Barringtonia acutangula</i> (L.) Gaertn.	Hijal (A)	March–Oct.	AB & DB 11729; AULS 2643	11	NE
Lythraceae J.St.-Hil.					
<i>Duabanga grandiflora</i> Walp.	Ramdala (B)	Feb.–June	AB & DB 11416; AULS 2647	5	NE
Malvaceae Juss.					
<i>Bombax ceiba</i> L.	Simolu (A)	Jan.–May	AB 11566; AULS 2659	12	NE
<i>Bombax insigne</i> Wall.	Bon Semal (B), Showy silk cotton tree (E)	Nov.–March	AB 11567; AULS 2667	2	NE
<i>Sterculia versicolor</i> Wall.	Durong (A and Bodo)	March–June	AB & DB 11514; AULS 2688	1	NE
Meliaceae Juss.					
<i>Aglaia spectabilis</i> (Miq.) S. S. Jain & Bennet	Amari, Bhoto-mayna (A)	Sept.–Nov.	AB & DB 11778; AULS 2690	16	LC
<i>Aphanamixis polystachya</i> (Wall.) R. Parker	Not known	May–Apr.	AB & DB 11727; AULS 2555	3	LC
<i>Azadirachta indica</i> Juss.	Neem (A)	March–July	AB & DB 11726; AULS 2572	way to 5	NE
<i>Chukrasia tabularis</i> A.Juss.	Boga poma, Hatia (A), Chikrassi (B)	June–Oct.	AB & DB 11758; AULS 2596	6	LC
<i>Dysoxylum gotadhora</i> (Buch.-Ham.) Mabb.	Bandardima (A), Bandarfela (B)	March–Nov.	AB & DB 11759; AULS 2631	6	NE
<i>Melia azedarach</i> L.	Ghura Neem (A)	March–Dec.	AB & DB 11453; AULS 2653	5	NE
<i>Toona ciliata</i> M. Roem.	Poma (A), Red cedar (E)	Jan.–Aug.	AB & DB11454; AULS 2680	5	LC
Moraceae Gaudich.					
<i>Artocarpus heterophyllus</i> Lam.	Kathal (A)	March–Aug.	AB & DB 11570; AULS 2686	5	NE
<i>Artocarpus chama</i> Buch.-Ham.	Cham (A)	March–Aug.	AB & DB 11764; AULS 2663	6	NE
<i>Artocarpus integra</i> (Thunb.) Merr.	Kathal (A, B)	Feb.–Sept.	AB & DB 11765; AULS 2676	11	NE
<i>Artocarpus lacucha</i> Buch.-Ham.	Bohot (A), Dewa (B), Monkey Jack (E)	Feb.–Aug.	AB & DB 11766; AULS 2665	6	NE
<i>Ficus benghalensis</i> L.	Bat (B)	Apr.–Nov.	AB & DB 11570; AULS 2569	11	NE
<i>Ficus benjamina</i> L.	Jari gach (A)	Oct.–Apr.	AB & DB 11571; AULS 2561	3	NE
<i>Ficus hispida</i> L.f.	Not known	June–July	AB & DB 11517, 11618; AULS 2574	11, 16	NE
<i>Ficus palmata</i> Forssk.	Wild fig/Punjab Fig (E), Anjiri (H)	June–Sept.	AB & DB 11423, 11482; AULS 2591	5, 10	NE
<i>Ficus racemosa</i> L.	Dumur (B)	Feb.–Sept.	AB & DB 11767; AULS 2598	6	NE
<i>Ficus religiosa</i> L.	Anhat gach (A)	Apr.–Sept.	AB & DB 11572; AULS 2627	1	NE
Moringaceae Martinov					
<i>Moringa oleifera</i> Lam.	Sojina (A), Drum Stick tree (E)	Year round	AB & DB 11725; AULS 2670	Balacherra near 16	NE
Myrtaceae Juss.					
<i>Psidium guajava</i> L.	Madhuriam (A), Guava (E)	Apr.–Oct.	AB & DB 11723; AULS 2683	6	NE
<i>Syzygium cumini</i> (L.) Skeels	Jamuk (A), Jamun (B), Blackpalm (E)	Feb.–Sept.	AB & DB 11722; AULS 2578	roadside at 1	NE
<i>Syzygium kurzii</i> (Duthie) N. P.Balacr.	Bogi Jamuk (A)	Apr.–Oct.	AB & DB 11415; AULS 2590	Roadside at 3	NE

Table 2. Continued.

Scientific name	Vernacular name	Phenology	Voucher specimens	Occurrence	Threat status
Oleaceae Hoffmanns. & Link					
<i>Nyctanthes arbortritis</i> L.	Sewali (A), Shephalika (B)	Aug.–Jan.	AB 11720; AULS 2612	Kalaincherra near 8	NE
Primulaceae Batsch ex Borkh.					
<i>Ardisia paniculata</i> Roxb.	Not known	Year round	AB 11683; AULS 2629	12	NE
<i>Maesa ramentacea</i> Wall.	Not known	Jan.–Dec.	AB & DB 11376; AULS 2646	4 (on way to 1)	NE
Rhamnaceae Juss.					
<i>Zizyphus jujuba</i> Mill.	Bogori (A)	May–Oct.	AB & DB 11706; AULS 2675	1	LC
<i>Zizyphus rugosa</i> Lamk.	Suran (H), Bon-boroi (Sylh.)	Nov.–Jan.	AB 11705; AULS 2668	8	NE
Rubiaceae Juss.					
<i>Chassalia curviflora</i> (Wall.) Thwaites var. <i>longifolia</i> Hook.f.	Not Known	May–July	AB & DB 11477, 11491; AULS 2559	10	NE
<i>Morinda angustifolia</i> Roxb.	Not known	Apr.–Oct.	AB & DB 1481, 11627; AULS 2565	10, 11	NE
<i>Neolamarckia cadamba</i> (Roxb.) Bosser	Kadam (A)	June–Nov.	AB & DB 11704; AULS 2616	1	NE
<i>Wendlandia budleioides</i> Wall. ex Wight & Arn.	Not known	Aug.–Dec.	AB & DB 11424; AULS 2624	5	NE
Rutaceae Juss.					
<i>Aegle marmelos</i> (L.) Correa	Bel (A and B)	Apr.–Aug.	AB & DB 11702; AULS 2587	10	NE
<i>Citrus maxima</i> (Burm.) Merr.	Robab tenga (A), Chinese grapefruit (E)	Apr.–Dec.	AB & DB 11701; AULS 2595	6	NE
<i>Clausena heptaphylla</i> (Roxb. ex DC.) Wight & Arn. ex Steud.	Koronful (B)	Apr.–July	AB & DB 11634; AULS 2576	11	NE
<i>Micromelum integerrimum</i> (Roxb. ex DC.) Wight & Arn. ex M.Roem.	Not known	Feb.–Sept.	AB & DB 11527; AULS 2656	16	NE
Sabiaceae Blume					
<i>Meliosma pinnata</i> (Roxb.) Maxim.	Not known	May–Oct.	AB & DB 11598; AULS 2679	1	NE
Salicaceae Mirb.					
<i>Gynocardia odorata</i> Roxb.	Bonsha, Bandarpele (A), Chhalmogra (H)	Jan.–Aug.	AB & DB 11494; AULS 2649	near Bhaluk Nala at 10	NE
Sapindaceae Juss.					
<i>Sapindus mukorossi</i> Gaertn.	Manishal (A), Ritha (B), Sukathaiphang (Di)	May–Nov.	AB & DB 11597; AULS 2658	1	NE
Sapotaceae Juss.					
<i>Mimusops elengi</i> L.	Bakul (A)	May–Sept.	AB & DB 11596; AULS 2632	1	NE
Theaceae Mirb. ex Ker Gawl.					
<i>Schima wallichii</i> (DC.) Korth.	Makria, Noga-bhe (A), Chilauni (B)	Apr.–Dec.	AB & DB 11422; AULS 2682	5	NE
Ulmaceae Mirbel					
<i>Trema orientalis</i> Blume	Jiban (B), Gunpowder tree (E)	Apr.–Dec.	AB & DB 11528; AULS 2579	16	NE
Urticaceae Juss.					
<i>Oreocnide integrifolia</i> (Gaudich.) Miq.	Ban rhea, Bon rhea (A), Wild Rhea (E),	March–Sept.	AB & DB 11387, 11609; AULS 2589	3, 11	NE
Verbenaceae J.St.-Hil.					
<i>Gmelina arborea</i> Roxb. ex Sm.	Gamari (A), Gamhar (H)	March–June	AB & DB 11589; AULS 2618	11, 6	NE
<i>Tectona grandis</i> L.f.	Segun (A)	Aug.–Jan.	AB 11588; AULS 2626	12	NE
Monocotyledons					
Arecaceae C.H. Schultz					
<i>Areca catechu</i> L.	Tamul (A), Supari (B), Betel nut (E)	Apr.–Sept.	AB & DB 11561; AULS 2636	15	NE
<i>Caryota urens</i> L.	Chewa gach (A), Fishtail Palm (E)	June-Sept.	AB & DB 11738; AULS 2652	1	LC
<i>Licuala peltata</i> Roxb. ex Buch.-Ham.	Chatta-pat (A)	June–Sept.	AB & DB 11498; AULS 2581	near Bhaluk Nala at 10	NE
Poaceae Barnhart					
<i>Bambusa balcooa</i> Roxb.	Bhuluka banh (A), Guadua Bamboo (E)	Jan.–Aug.	AB & DB 11773; AULS 2586	6	NE
<i>Bambusa cacharensis</i> R.B. Majumdar	Betua (B)	Apr.–Nov.	AB & DB 11355, 11356, 11664; AULS 2577	5 (way to 1), near Bhaluk Nala at 10	NE
<i>Bambusa tulda</i> Roxb.	Bijuli banh (A)	Jan.–June	AB & DB 11774; AULS 2584	11	NE
<i>Bambusa vulgaris</i> Schrad. ex J.C.Wendl.	Tansti banh (A)	Not seen	AB & DB 11772; AULS 2639	near Bhaluk Nala at 10	NE

Table 2. *Continued.*

Scientific name	Vernacular name	Phenology	Voucher specimens	Occurrence	Threat status
<i>Dendrocalamus hamiltonii</i> Nees & Arn. ex Munro	Kako banh (A)	Oct.–May	AB & DB 11354, 11680; AULS 2655	way to 1, near Bhaluk Nala at 10	NE

Table 3. List of lianas with their vernacular name, phenology, collection number, occurrence and threat status. Abbreviations, languages: A = Assamese, B = Bengali, E = English, H = Hindi, Kh = Khasi, Mik. = Mikir; IUCN status: LC = Least Concern, NE = Not Evaluated. Occurrence: see Table 1 for a key to locations.

Scientific name	Vernacular name	Phenology	Voucher specimens	Occurrence	Threat status
Dicotyledons					
Acanthaceae Juss.					
<i>Thunbergia grandiflora</i> Roxb.	Kukua loti (A), Neel lota (B)	Sept.–Jan.	AB 11421, 11693; AULS 2603	2, 5	NE
Anacardiaceae R.Br.					
<i>Pegia nitida</i> Colebr.	Not known	Jan.–July	AB & DB 11420; AULS 2622	5	NE
Apocynaceae Juss.					
<i>Anodendron paniculatum</i> A. DC.	Not known	Apr.–Dec.	AB & DB 11612; AULS 2642	11	NE
<i>Hoya globulosa</i> Hook.f.	Not known	Apr.–July	AB & DB 11460; AULS 2685	10	NE
Combretaceae R.Br.					
<i>Combretum indicum</i> (L.) DeFilipps	Not known	March–Nov.	AB & DB 11742; AULS 2662	11	NE
<i>Combretum pilosum</i> Roxb.	Not known	Dec.–March	AB & DB 11579; AULS 2673	3	NE
<i>Combretum wallichii</i> DC. var. <i>deciduum</i> Gang. & T. Chakrab.	Not known	March–Nov.	AB & DB 11426; AULS 2606	5	NE
Convolvulaceae Juss.					
<i>Argyreia nervosa</i> (Burm.f.) Bojer	Bichtarak, Goguli (B), Jomang-pi-danok-soh-ring-kang (Mik.)	Oct.–March	AB 11687; AULS 2620	2	NE
Fabaceae Lindl.					
<i>Entada gigas</i> (L.) Fawc. & Rendle	Not known	March–Oct.	AB & DB 11417; AULS 2650	5	NE
<i>Mucuna imbricata</i> (Roxb.) DC.	Makori ghila (A), Horse eyebean (E)	June–Nov.	AB 11503; AULS 2638	Kalaincherra (through 8)	LC
<i>Phanera glauca</i> Wall. ex Benth.	Not known	Apr.–Sept.	AB 11358, 11694, 11512; AULS 2664	2	LC
<i>Phanera ornata</i> Kurz var. <i>kerrii</i> (Gagnep.) K.Larsen & S.S.Larsen	Not known	May	AB 11691; AULS 2671	2	NE
<i>Phanera scandens</i> (L.) Raf.	Snake Climber, Monkey ladders (E), Nagbeli (H)	Sept.–Dec.	AB & DB 11534; AULS 2609	16	NE
<i>Phanera vahlii</i> (Wight & Arn.) Benth.	Kanchan lota, Nak-kati-lewa (A)	Apr.–Jan.	AB 11495, 11682; AULS 2611	near Bhaluk Nala at 10, 12	NE
<i>Phanera wallichii</i> Thoth.	Not known	Apr.–July	AB & DB 11601; AULS 2614	11	LC
<i>Pueraria montana</i> (Lour.) Merr. var. <i>lobata</i> (Willd.) Maesen & S. M.Almeida ex Sanjappa & Predeep	Kudzu (H)	July–Oct.	AB 11696; AULS 2633	2	NE
Hernandiaceae Blume					
<i>Illigera khasiana</i> C.B. Clarke	Kerkerilata (A)	August–Apr.	AB & DB 11427; AULS 2641	5	NE
Malvaceae Juss.					
<i>Byttneria aspera</i> Colebr. ex Wall.	Not known	Mar.–Oct.	AB & DB 11463; AULS 2634	10	NE
Menispermaceae Juss.					
<i>Tinospora crispa</i> Miers.	Gulanha (B), Heartleaf moonseed (E)	Mar.–Oct.	AB & DB 11523; AULS 2666	16	NE
Moraceae Gaudich.					
<i>Poikilospermum suaveolens</i> (Blume) Merr.	Jog-kag, kamlata (B)	Apr.–June	AB & DB 11478; AULS 2604	10	NE
Piperaceae Giseke.					
<i>Piper nigrum</i> L.	Jaluk (A), Black pepper (E), Kali mirch (H)	June–Oct.	AB & DB 11713; AULS 2669	1	NE
Sabiaceae Blume					
<i>Sabia lanceolata</i> Colebr.	Not known	Oct.–Dec.	AB & DB 11369, 11430; AULS 2691	4, 5	NE
Monocotyledons					
Smilacaceae Ventenat					
<i>Smilax zeylanica</i> L.	Kumarika (B)	June–Dec.	AB 11535; AULS 2692	12	NE

Combretaceae (3 spp.) and Apocynaceae (2 spp.) (Fig. 5). The rest of the 9 families had a single species recorded. The dominant genera were *Phenera* (5 spp.) and *Combretum* (3 spp.). Among the monocotyledonous lianas, a single species (of Smilacaceae) was recorded. Photographs of several species are shown in Figs 8–11.

Common timber yielding trees recorded in the sanctuary were *Artocarpus chama* Buch.-Ham., *A. heterophyllus* Lam., *Azadirachta indica* Juss., *Gmelina arborea* Roxb. ex Sm., *Melia azedarach* L., *Mimusops elengi* L., *Shorea robusta* C.F.Gaertn., *Tectona grandis* L.f., *Terminalia chebula* Retz., and *Toona ciliata* M. Roem. Common in the BWS were edible species of fruit trees: *Aegle marmelos* (L.) Correa, *Carica papaya* L., *Dillenia indica* L., *Elaeocarpus floribundus* Blume, *Mangifera indica* L., *Phyllanthus emblica* L., *Syzygium cumini* (L.) Skeels, *Tamarindus indica* L., and *Zizyphus jujuba* Mill. Other common species of the sanctuary were *Bombax ceiba* L., *Cinnamomum tamala* (Buch.-Ham.) T.Nees & C.H.Eberm., *Ficus benghalensis* L., *F. religiosa* L., *Murraya koenigii* (L.) Spreng., and *Oroxylum indicum* (L.) Kurz. Among the bamboos, *Bambusa vulgaris* Schrad. ex J.C.Wendl. and *Dendrocalamus hamiltonii* Nees & Arn. ex Munro were common in the forest areas. Dominant palm species of the sanctuary were *Areca catechu* L., *Caryota urens* L., and *Licuala peltata* Roxb. ex Buch.-Ham.

Among the lianas, some commonly occurring species recorded were *Combretum indicum* (L.) DeFilipps, *Entada gigas* (L.) Fawc. & Rendle, *Phanera glauca* Wall. ex Benth., *Thunbergia grandiflora* Roxb., and *Tinospora crispa* Miers.

Flowering and fruiting phenology (Figs 6, 7). For trees, the flowering was mostly in March (pre-monsoon) to August (post-monsoon), but peaked in June; the peak in fruit production was in the late dry season (August to December). For lianas, flowering peaked in April to July (pre-monsoon and monsoon) and fruit production peaked in the late dry season (August to December).

IUCN Red List categories. Of all species recorded, only 1 tree species (Vulnerable) is threatened; all other species are categorized as Least Concern, Data Deficient, or are Not Evaluated.

Discussion

Our results indicate a rich flora in the BWS, possibly due to the region's physiography of undulating hills and hillocks and tropical to subtropical climate.

Recently, Barbhuiya (2013a) recorded several species from the BWS that we failed to find. These are: *Actinodaphne obovata* (Nees) Blume, *Balakata bacata* (Roxb.) Esser, *Catunaregam spinosa* (Thunb.) Tirveng., *Cinnamomum bejolghota* (Buch.-Ham.) Sweet, *Croton joufra* Roxb., *Meliosma simplicifolia* (Roxb.) Walp., *Prismatomeris tetrandra* K. Schum., and *Toxicodendron bimannii*. Some earlier collections were also found in the herbarium of Botanical Survey of

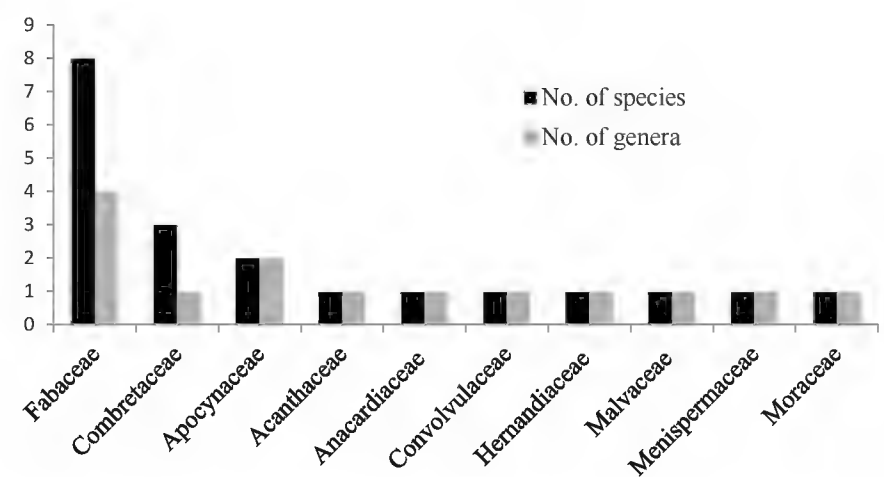


Figure 5. Dominant liana families with number of species and genera.

India at ASSAM, which could also not be traced in the field. These are: *Abroma augustum* (L.) L.f., *Archidendron clypearia* (Jack) I.C. Nielsen, *Camellia oleifera* C. Abel, *Dalbergia stipulacea* Roxb., *Dendrocnide sinuata* (Blume) Chew, *Hodgsonia macrocarpa* (Blume) Cong., *Ocotea lancifolia* Mez, *Sterculia villosa* Roxb. ex Sm., and *Styrax serrulatus* Roxb. This might be due to their localized distribution or their rarity in the sanctuary. Additional fieldwork is needed to locate these species in BWS.

Although, most parts of the BWS is still virgin, human habitations in and around the sanctuary exist (8 in East Block; 19 in West Block; Anonymous 2006). With an increasing population, villagers' demands on the forest and its products are increasing with the collection of bamboos, canes, and timber. Clearing of forests for the cultivation of areca nut, beetle leaf, pineapple, and banana is leading to a loss of biodiversity at the forest margins. Massive habitat loss in the buffer zone also

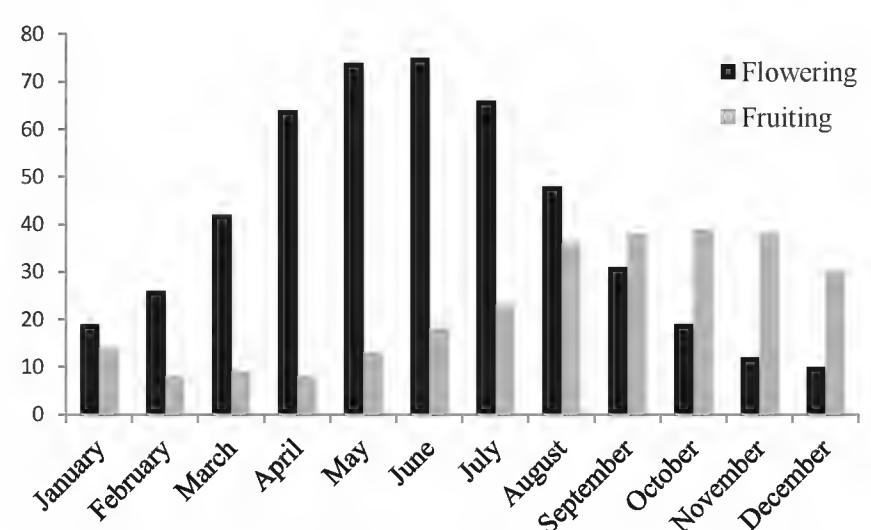


Figure 6. Phenology of the recorded tree species.

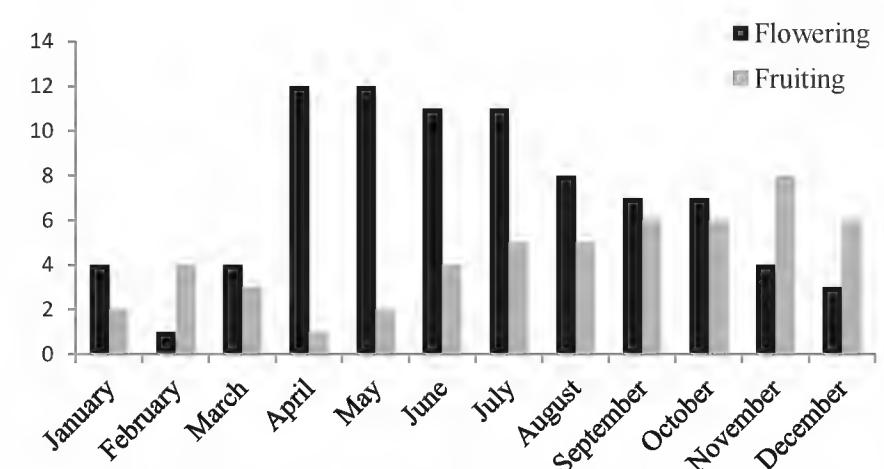


Figure 7. Phenology of the recorded liana species.

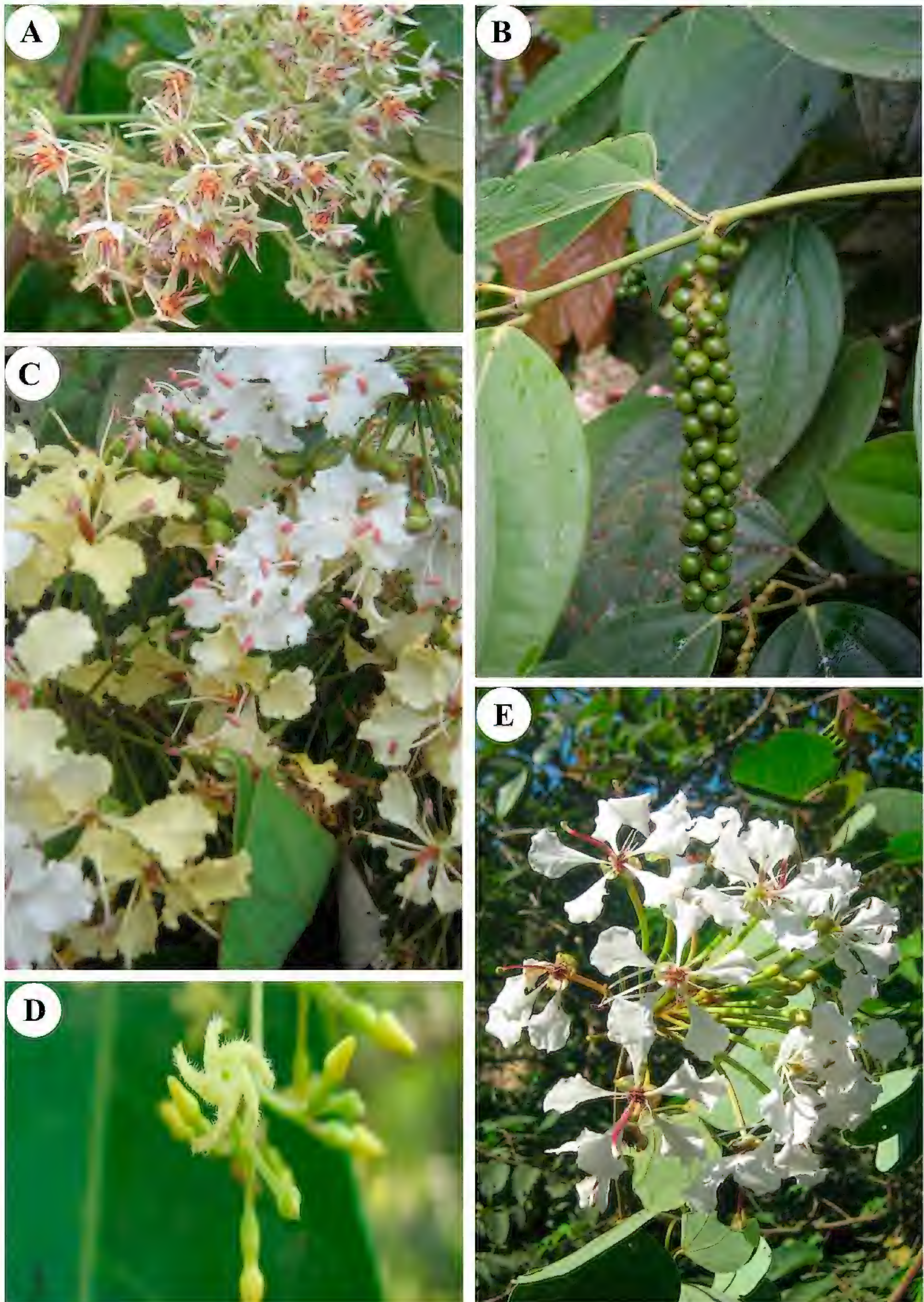


Figure 8. A. *Byttneria aspera*. B. *Piper nigrum*. C. *Phanera vahlii*. D. *Anodendron paniculatum*. E. *Phanera glauca*.

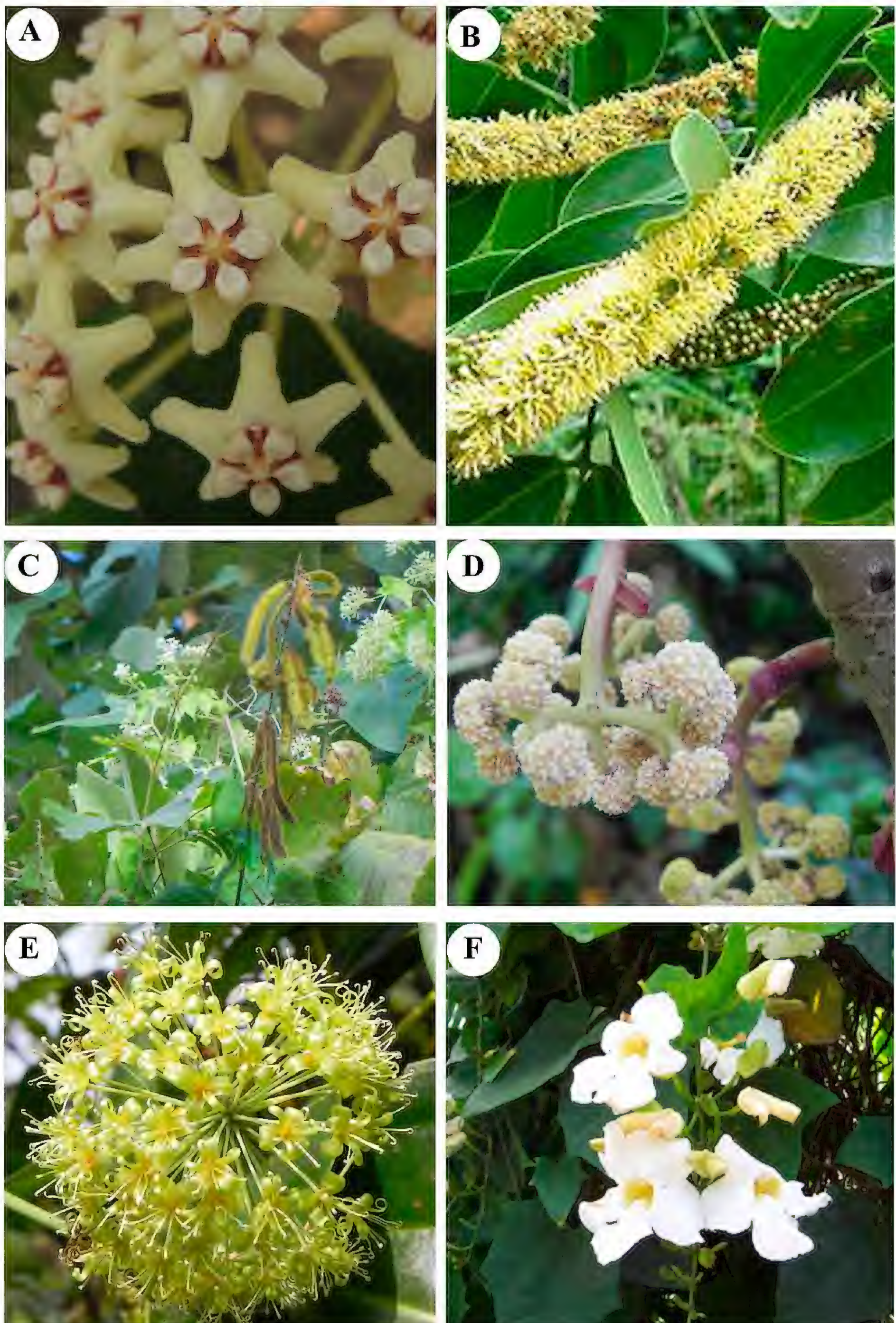


Figure 9. A. *Hoya globulosa*. B. *Entada gigas*. C. *Pueraria montana* var. *lobata* (Front fruiting twig). D. *Poikilospermum suaveolens*. E. *Smilax zeylanica*. F. *Thunbergia grandiflora*.

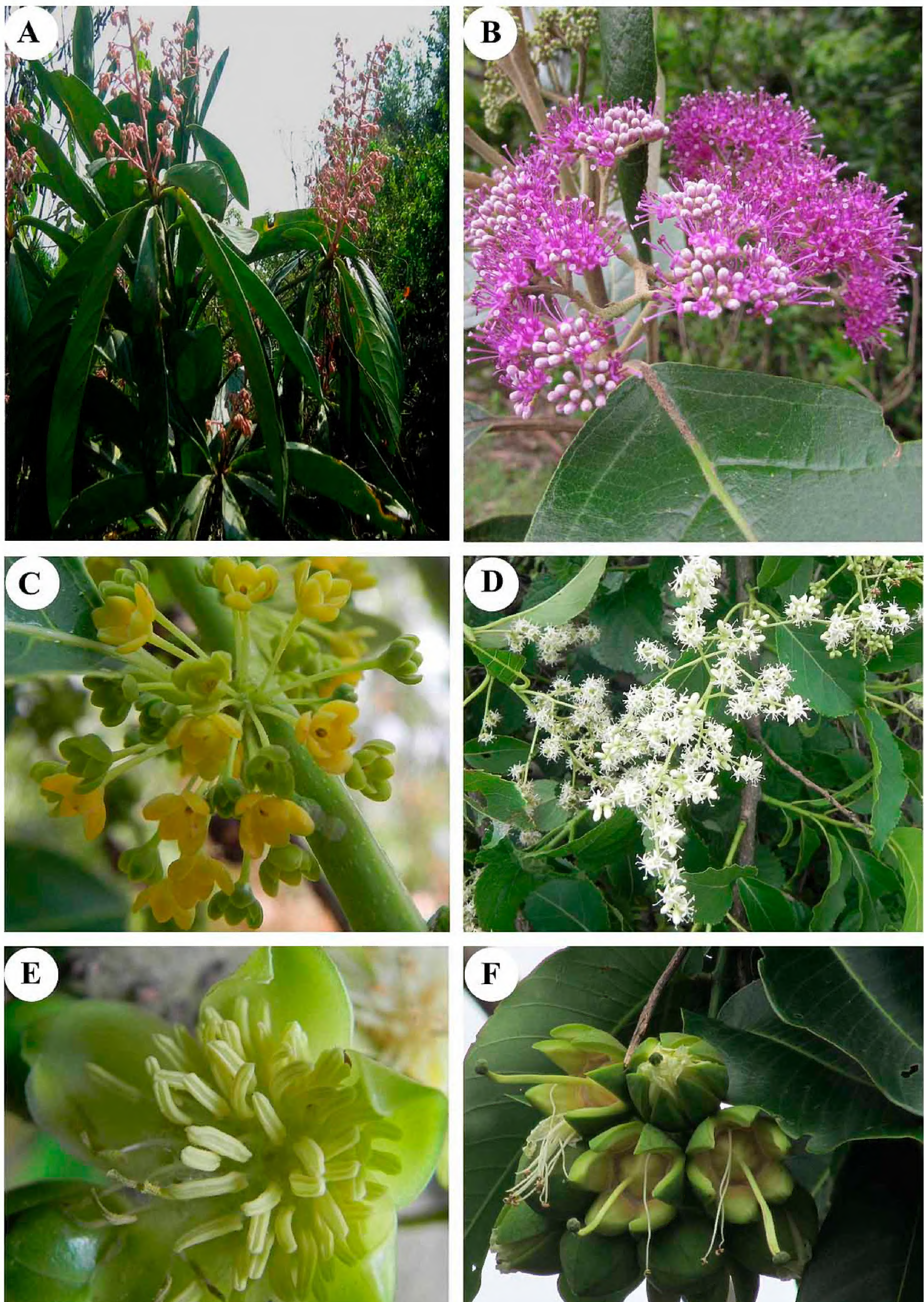


Figure 10. **A.** *Ardisia paniculata*. **B.** *Callicarpa arborea*. **C.** *Glochidion lanceolarium*. **D.** *Ehretia acuminata*. **E.** *Gynocardia odorata*. **F.** *Duabanga grandiflora*.

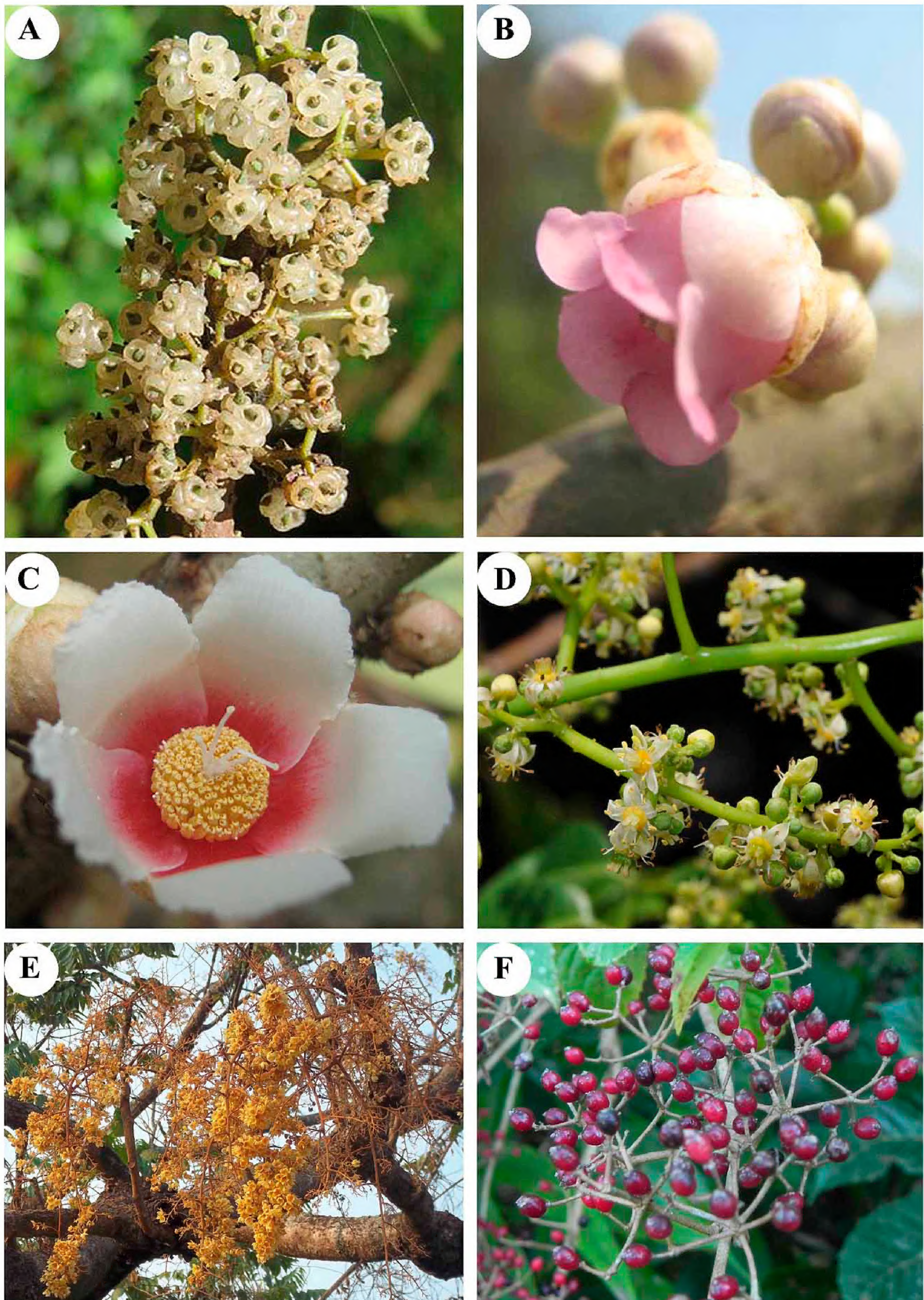


Figure 11. A. *Oreocnide integrifolia*. B. *Saurauia roxburghii*. C. *Saurauia cerea*. D. *Spondias pinnata*. E. *Sterculia versicolor*. F. *Viburnum cylindricum*.

results in species destructions. Other human activities, like road construction, cutting of forests for *jhum* (shifting) cultivation, areca nut plantation etc., along with some natural phenomena like landslides due to heavy rain, thunderstorms, and hailstorms, are also serious threats to biodiversity. Therefore, there is an urgent need for developing and implementing conservation strategies for the BWS.

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Authors' Contributions

AB carried out fieldwork for collecting specimens, identified the specimens, and drafted the manuscript. DB also took part in field and coordinated the work. Both authors interpreted the results, as well as read and approved the final content of the manuscript.

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